

1. A method of forming a rigid polyurethane foam attached to a substrate having an open cavity, comprising mixing a polyisocyanate component with a polyol component in the presence of at least one catalyst for the reaction of a polyol with a polyisocyanate and a blowing agent, dispensing the resulting mixture onto a substrate defining an open cavity and subjecting the mixture to conditions sufficient to cause the mixture to cure to form a foam having a bulk density of 3 to 40 pounds per cubic foot (48-640 kg/m<sup>3</sup>) that is adherent to the substrate, wherein
  - (a) the polyisocyanate component contains at least one compound having a plurality of free isocyanate groups,
  - (b) the polyol component contains isocyanate-reactive materials that have an average functionality of at least about 2.3 and includes at least one polyol and,
  - (c) the volume ratio of the polyisocyanate component to the polyol component is no greater than 5:1 and no less than 1:5,
  - (d) the ratio of isocyanate groups in the polyisocyanate component to the number of isocyanate-reactive groups in the polyol component is from about 0.7:1 to about 1.5:1;
  - (e) the blowing agent is a carbamate of an alkanolamine; and
  - (f) the cream time of the mixture is less than 2 seconds.

2. The method of claim 1 wherein the carbamate is contained in a non-aqueous medium.

3. The method of claim 2 wherein the carbamate is a reaction product of carbon dioxide and N-methyl-2-aminoethanol, N-ethyl-2-aminoethanol, 2-(2-N-methyl-aminoethyl)-1,2-ethanediol, N,N'-bis-(β-hydroxyethyl)-ethylene diamine, N,N'-bis-(β-hydroxypropyl)ethylene diamine, N,N'-bis-(β-hydroxyethyl)-1,2-propylene diamine, N,N'-bis-(β-hydroxypropyl)-1,3-propane diamine, N,N'-bis-(β-hydroxyethyl)-1-methyl-2,4-diaminocyclohexane N,N'-bis-(β-hydroxyethyl)-1-methyl-2,6-diaminocyclohexane, N,N'-bis-(β-hydroxypropyl)-p-xylylene diamine, N-(β-hydroxyethyl-N'-(β-hydroxypropyl) ethylene diamine or tris-(β-hydroxyethyl)-1,6,11 triaminoundecane

4. The method of claim 2 wherein the carbamate is the reaction product of carbon dioxide and an alkanolamine having the structure



where  $y$  is at least 1,  $z + y$  equals 3,  $\text{R}'$  and  $\text{R}''$  are independently hydrogen, ethyl or methyl,  $x$  is a number from 1 to 4, and  $a$  is 1 or 2, provided that  $a$  times  $y$  is not greater than 2.

5. The method of claim 4 wherein the alkanolamine is 2-(2-aminoethoxy)ethanol or 2-(2-(2-aminoethoxy)ethoxy)ethanol.

6. The method of claim 1 wherein the isocyanate-terminated prepolymer component is a reaction product of an organic polyisocyanate and at least one polyol.

7. The method of claim 1 wherein the isocyanate-terminated prepolymer is a reaction product of an organic polyisocyanate, at least one polyol and a hydroxyl-functional acrylate or methacrylate.

8. The method of claim 6 wherein the polyisocyanate component includes at least one plasticizer.

9. The method of claim 1 wherein at least one polyol in the polyol component contains a tertiary amine group.

10. The method of claim 1 wherein the polyol component contains at least one amine-terminated polyether.

11. The method of claim 1 wherein the blowing agent is blended into the polyol component before the polyol component and polyisocyanate component are mixed.

12. The method of claim 1 wherein the catalyst is blended into the polyol component before the polyol component and polyisocyanate component are mixed.

13. The method of claim 1 wherein the cream time is less than 1 second.

14. The method of claim 1 wherein the substrate having an open cavity is an automotive part.

15. The method of claim 14 wherein the automotive part is assembled onto a vehicle or vehicle frame when the foam formulation is applied and foamed.

16. The method of claim 15 wherein the automotive part is a pillar, rocker, sill, sail, cowl, plenum, seam, frame rail, vehicle sub assembly, hydro-formed part, cross car beam or engine cradle.